

PROPOSAL

ECONOMICAL MACHINE TRANSLATION SYSTEM

A PROPOSAL TO  
CENTRAL INTELLIGENCE AGENCY  
FOR THE SUPPORT OF THE DEVELOPMENT OF AN  
ECONOMICAL MACHINE TRANSLATION SYSTEM  
PRESENTED BY  
MACHINE TRANSLATION INC.

May 20, 1959

## TABLE OF CONTENTS

	<u>Page</u>
Introduction. . . . .	1
Objectives and Anticipated Results . . .	3
Development Program . . . . .	4
Development of System to Speed-up the Translation Process. . . . .	4
Development of Dictionaries in the Form Required by the Machine Trans- lation System . . . . .	7
Development of Equipment to Speed up Preparation of Material for Translation . . . . .	8
Study of Systems and Equipment. . . .	10
Staffing . . . . .	11
Outside Consultation. . . . .	12
Cost Proposal . . . . .	13
Financial Ability . . . . .	15
Starting the Project . . . . .	16
Special Qualifications for the Project . . . . .	16
Resumes, Machine Translation Inc. . . . .	17
Cooperation with C-E-I-R Inc. . . . .	23

### INTRODUCTION

This is a proposal to undertake an intensive program to develop a machine translation system which will be economical and competitive with human translators. The new system will be based on the principles of the experimental Code Matching Technique.

\* \* \*

Since 1954 extensive research on machine translation has been carried out by a number of universities and private organizations in this country, the Soviet Union and England. Practically all of these endeavors have been supported by government funds. At least in this country and in England, the efforts have been exploratory in nature and may be characterized as research as differentiated from development.

A breakthrough came last year when Ariadne Lukjanow announced her Code Matching Technique (CMT) and performed a demonstration of the world's first practical system for automatic translation of languages. The demonstration was attended by representatives from the Central Intelligence Agency, the Armed Forces, the Department of Defense, and other interested government agencies.

The demonstration consisted of several articles of Russian chemical literature which was translated into English using an IBM 704 computer. Two of the articles had never been seen

by the research staff. The National Science Foundation reported, "The evaluation by chemists on the intelligibility and completeness of the text was positive."

In a subsequent demonstration on November 20th, 1958, before the International Scientific Congress, articles from other fields of knowledge were demonstrated using improved programs.

\* \* \*

These tests were not designed to produce perfect translations but primarily to prove that machine translation is a practical possibility.

The CMT system is experimental and possesses too many practical limitations to render it useful except in a scientific sense. The basic points and principles of the system, however, represent the foundation on which a truly operational system can be structured. The research is an accomplished fact; the development is the next logical step.

Machine Translation Inc. proposes to develop this discovery to the point of practical application. This will entail: the development of a refined and improved system for the computer; the development of a faster and more efficient method and equipment to prepare the source language for introduction into the computer; the coding and up-dating of dictionaries in the required form.

\* \* \*



-3-

OBJECTIVES AND ANTICIPATED RESULTS

The proposed one year program will bring us to the following levels of achievement:

1. A system with operational capacity to translate 25,000 to 50,000 words per hour depending on the computer used.
2. The system will yield a useable and commercially acceptable product.
3. The system will lend itself to the translation of several languages, singly or simultaneously.
4. The dictionary of the system will permit the translation of material in several (at least seven) scientific disciplines as well as general text (except poetry and literary works).
5. The expected size of the dictionary is 400,000 to 500,000 words, to consist of a <sup>General</sup> ~~General~~ Dictionary, General Technical Dictionary, and seven dictionaries in various specialized subject matters or scientific disciplines. The dictionaries will be prepared for translation of Russian into English.
6. Experimental dictionaries of approximately 500 words each will be prepared for testing purposes in the following languages: Russian into German, French, and Spanish; German into English; French into English; English into Chinese, and other combinations of the languages mentioned.

-4-

7. Equipment will be developed and perfected to facilitate the efficient and economical preparation of input material for the computer.

The same equipment will be used to prepare the dictionaries and semi-automatically post-edit the output.

#### THE DEVELOPMENT PROGRAM

For purposes of description, the proposed venture may be presented in four separate work phases. In practice, these stages will not be undertaken in numerical order. Rather, they overlap and may be carried out simultaneously.

##### 1. Development Of System To Speed-up The Translation Process

The present CMT system is an experimental model. The decimal coding employed is not the most advantageous number-system to use on a computer. The segmented individual operations; long, fixed length records; complex linguistically oriented logic, and too extensive use of macroprogramming and subroutines make it almost impossible as a production model. It has served its purpose as an experimental model. It proved that a system of this type operates, yields translation and that the principles of the approach are valid.

We propose to develop and perfect a new system, which will:

- (a) Take advantage of the machine's ability to handle octal numbers.
- (b) Utilize code patterns, which will:
  - (1) Simplify, speed up dictionary preparations, allowing to assign automatically on the machine code patterns to the words and their equivalents, which will then be checked manually.
  - (2) Produce much shorter records in the dictionary, resulting in reduced machine time during the translation processes.
- (c) Further shorten records by the use of minimum l's coding, resulting in an elimination of all redundant material.
- (d) Further shorten records through the elimination of repetitions in the target language equivalents, based on the fact that many paradigms even of different stems can yield the same target language equivalent.
- (e) Further shorten records through the use of variable length records in all stages of the system.



-6-

- (f) Operate on simplified logic based on new ideas (with respect to MT systems) of arithmetic progression of codes; elimination of qualified and partial matching, fragmentation of units, and matching at two levels. In addition, new ideas of antecedent storage will be incorporated. All matching operations will become relative, the data remaining stationary within the machine. Logic will be more abstract, less linguistically oriented, more suited for machine operations.
- (g) Be streamlined and will flow as a single process, without human intervention, from input of source language to final output of target language.
- (h) Additional optional features which can be considered are:
  - production of output tapes which will allow post editing and correction on an automatic basis if desired, and
  - provision for upper and lower case printouts on final output, as well as syllabication to provide a more presentable format, and
  - provision for introduction of graphic materials.
- (i) Add programs to achieve simultaneous translations

-7-

into two or more languages, on an optional basis, requiring only one pass of the entire data.

The proposed system would still probably be uneconomical on the IBM 704 and marginal on the IBM 709. However, the planned compatibility of the IBM 709 with the IBM 7090 (which will be available in January, 1960) coupled with the 5 to 1 speed increase at only 15% increase in price, will render the process economically desirable and competitive in price with human translators.

2. Development of Dictionaries in the Form Required  
by the Machine Translation System.

The staff of the corporation will seek to produce dictionaries of approximately 500,000 words in the form required by the new translation process.

The dictionaries will be prepared for translation of Russian into English. Each word will be coded and recorded on paper and on magnetic tape ready for the translation process in the computer.

It is advisable to first produce a General Dictionary and a General Technical Dictionary prior to the development of Specialized Dictionaries in various fields of knowledge and scientific disciplines. The exact number of words

coded and recorded within the course of one year will depend on which fields are selected for the Specialized Dictionaries as well as on the availability of lexical data in these fields.

Staff members have already formulated an approach for speedy machine preparation of dictionaries and for the up-dating of the dictionaries. This approach is ready for final development. The equipment required is identical to that to be used in the preparation of the source language for insertion into the computer. This equipment is described in section 3. below.

### 3. Development of Equipment to Speed Up Preparation of Material for Translation.

Under the present system, the source language to be translated is punched word for word on IBM cards. These cards are then transferred to a magnetic tape, which is mounted on the computer tape units.

This method of input for machine translation is strictly experimental. It is slow and costly. The card allows no visual checking of the typing, and even a minor typing error results in serious disruption in the translation process. Furthermore, the IBM punch key board is too limited to accept both the Roman and Cyrillic alphabets as well as necessary punctuation marks, mathematical and

scientific symbols, and initial capitalization.

We propose to develop and perfect a method and equipment which will eliminate these shortcomings. The following approach appears most fruitful: The source language is typed on a modified Flexowriter or other machine of similar type; the source language appears simultaneously on a punched paper tape and in its original form on a sheet of paper. The text on the paper is then checked against the original document and corrections are made. The tape is corrected accordingly by a speedy and completely mechanized process. The text on the paper tape is then converted to a magnetic tape, which is fed directly into the computer.

This phase of the proposed program does not necessitate the construction of special equipment but required merely the <sup>adaptation</sup> ~~adaption~~ of modification of existing Flexowriters or similar machines. Some preparatory work has already been carried out and the basic principles and changes in equipment have been successfully tested.

The proposed method will assure the accuracy of the material introduced into the computer, it will increase the input speed, and the equipment used is less costly than present machinery. Furthermore, the proposed

method will greatly facilitate the preparation and updating of the dictionaries.

4. Study of Systems and Equipment.

The Corporation proposes to study present standard computers in order to select the computer best suited for machine translation. Alterations and modifications of existing computers to render them more efficient will also be considered.

The corporation proposes to explore the possibility of developing new and inexpensive auxiliary equipment to handle some of the functions presently performed on the more expensive computers. At present, for example, 40 minutes of every hour spent on the IBM 704 computer are devoted to sorting of input data and conversion of material, and only 20 minutes are used for the actual translation process.

As possible later endeavors, the corporation may undertake to study and assist in the development of other equipment to achieve:

- (a) automatic data preparation systems
- (b) audio-translation systems
- (c) information retrieval systems.

STAFFING

The project will be staffed as follows:

Project Leader and Principal Investigator (1)

Duties: Direct and supervise all research and  
and development activities.

Administrative Director (1)

Duties: Supervise and manage all business activities  
concerning the project.

Project Secretary (1)

Duties: Technical secretarial services; preparation  
of Handbook.

Assistant to Project Leader (2)

Duties: Assist in coding and editing of dictionaries.

Senior Programmer (1)

Duties: Systems engineering.

Programmers (2)

Duties: Assist Sr. Programmer in preparing flow charts,  
programming, supervision of contractors, etc.

Clerical Supervisor (1)

Duties: Maintain all files; supervise Flexowriter  
operators.

Flexowriter Operators (5)

Duties: Filing; typing of dictionaries and texts.



Bookkeeper, Secretary (1)

Duties: Maintain financial records, pay bills,  
prepare vouchers, provide administrative  
secretarial services.

TOTAL:

15

OUTSIDE CONSULTATION

A reasonable amount of outside consultation may be required.

We are presently setting up an advisory board to consist of specialists in the various scientific disciplines which have a bearing on machine translation. The members of this board will advise us on problems that fall within their fields of specialization.

The interest in the scientific community for our proposed endeavor has proven highly encouraging. We are presently negotiating with -- and have already obtained the promise of support from several -- technical men with outstanding reputations from the following organizations: Institute for Advanced Study, Princeton University; Georgetown University; Massachusetts Institute of Technology; the Applied Physics Laboratory of the Johns Hopkins University; Curtis Publishing Company; Harvard University; various government agencies.

COST PROPOSAL

The following budget is proposed to cover the work over a 12 months period.

## 1. Personnel

Project Leader (1)	\$15,000
Project Secretary (1)	4,200
Administrative Director (1)	15,000
Assistants to Project Leader (2)	17,500
Senior Programmer (1)	13,000
Programmers (2)	16,500
Clerical Supervisor (1)	5,200
Flexowriter Operators (5)	22,500
Bookkeeper, Secretary (1)	5,200

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TOTAL SALARIES: \$114,100

## 2. Equipment and Contracted Services

(a) Data preparation machines (5), including prototype	\$20,000
(b) Computer time, coding services	58,000

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\$78,000

-14-

3. Expendable Technical Supplies	
Paper tape, dictionary cards, forms, etc.	\$10,000
4. Social Security, Insurance	\$3,500
5. Outside Consultants	\$2,000
6. Travel Allowances	
To attend technical meetings and to investigate equipment	\$2,500
7. Office Rent	\$4,300
8. Incidentals	
Telephone, heat, electricity, stationary, sanitary supplies, office equipment maintenance, subscriptions to technical publications, cleaning services, etc.	\$5,500
	<hr/>
TOTAL:*	\$219,900

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\* This total does not allow for a reasonable profit

FINANCIAL ABILITY

Machine Translation Inc. was established on May 4, 1959. The capitalization of the corporation is \$10,000.

A tentative agreement has been reached with the Bank of Commerce, Washington, D.C. According to this bank a contract between a government agency and our corporation for the proposed venture is a bankable instrument. The corporation presents the voucher to the bank, which immediately pays the corporation the stated amount. The bank then submits the voucher to the appropriate government agency, which reimburses the bank. This method is standard operating procedure for practically all research and development organizations doing business under government contract in this area.

Considering the bank support available, the corporation should encounter no financial difficulty in carrying out the proposed program. However, should the Central Intelligence Agency prefer that the capitalization of the corporation be increased, we will immediately secure the additional capital. It is available to the corporation on 24 hours notice.

### STARTING THE PROJECT

It is highly desirable to the corporation to begin operations on the proposed project as soon as possible after July first of this year. We would very much appreciate if the Central Intelligence Agency would render a decision at an early date, since the time necessary to prepare a detailed presentation is considerable.

### SPECIAL QUALIFICATIONS FOR THE PROJECT

The objectives of Machine Translation Inc. are to develop a machine translation system, to engage in the production of translations for the benefit of government agencies and private organizations, and to undertake research in the information retrieval field.

The technical staff of this corporation is unique. It is composed of the only people in the world who have developed a feasible machine translation system. Every member of the technical staff has devoted the past several years to intensive study, research, and experimentation in this field.

The following resumes are submitted to enable you to judge the caliber of our staff.

ARIADNE LUKJANOW

Technical Director, President

Simferopol Jr. College, Mathematics and Physics. University  
of Crimea, Department of Russian Philology, equiv. M.S.  
Breslau University, equiv. M.L.S. Rosary College, Chicago,  
Ill. Institute of Languages and Linguistics, Georgetown  
University, Washington, D.C.

Director of Library, Crimean Historical Museum. Librarian  
at Osteuropa-Institute, De Paul University, and Institute  
of Languages and Linguistics, Georgetown University.

Department head of the U. S. Army A. G. Civilian Personnel  
Office for Bremen-Bremerhaven area. Personnel Administrator  
of 18,000 employees at over 40 military installations.

Researcher, machine translation. Head of the Code Matching  
Technique Group, Georgetown University. Inventor of CMT  
system.

Author of "Statement on Proposed Method for Machine  
Translation", "Outline of Linguistic Considerations in  
Machine Translation", "CMT Code Matching", as well as a  
great number of technical papers, reports, studies, and  
articles.

Languages: Russian, English, German, minor Slavic languages.



-18-

DR. RUDOLF LOEWENTHAL

Senior Researcher

Ph. D. Economics, University of Berlin.

Independent research, professorial and teaching positions at Yenching University, Peiping; Cornell University; Institute of Languages and Linguistics, Georgetown University.

Ford Foundation special grant. Assigned as Director of Studies with the Division of Modern Languages at Cornell University.

American Council of Learned Societies and the Social Science Research Center grant for research project in European libraries.

Bibliographer, U. S. Information Agency.

Researcher, Machine Translation Project, Georgetown University. Edited dictionaries in preparation of tests.

Publisher of "Central Asian Collectanea". Associate editor of "Monumenta Serica", Nanzan University, Japan. Author of a great number of technical papers, research reports, studies, and articles published in the daily press and journals in the United States, England, China, Japan,

Germany and Holland.

Languages: English, German, French, Russian, Chinese,  
Swedish, Turkish.

JOHN E. HOLT

Director of Systems Engineering

George Washington University, School of Engineering.  
U.S. Department of Agriculture, Graduate School, Executive  
Training Program, IBM Corp. Specialized and advanced  
educational programs in computer operations at IBM Corp.,  
Sperry Rand Corp., Underwood Corp., Electro Data Corp.,  
National Cash Register Corp., and Burroughs Corp.

Systems consultant. Extensive programming experience  
while associated with U. S. Navy Bureau of Yards and Docks,  
Office of the Chief Signal Officer, Chief of Naval  
Operations Office, and Western Union Telegraph Corp.

Sr. Programmer, Machine Translation Research Project,  
Georgetown University. Prepared flow charts and system  
definitions. Supervised contractor in preparation of  
machine coded programs for test of CMT system. Participated  
in programming and debugging of operations on the IBM  
704 computer. Conducted demonstrations of the developed  
system.

HORST J. KUENDEL

Programmer

A.A. George Washington University. Extensive programming education in computer operations at IBM Corp. and Electro Data Corp.

Computer operator, Department of Defense. Translator, U. S. Joint Publications Research Service. Systems consultant.

Associate programmer, Machine Translation Research Project, Georgetown University.

Languages: English, German, French.

S. GORAN STACKIG

Vice President, Treasurer

B.S. in Business and Economics, American University. Royal School of Economics, Sweden. Graduate study at the School of Advanced International Studies, the Johns Hopkins University.

Intelligence Officer, U.S. Air Force.

Liaison executive, Scoville Manufacturing Company. Business consultant. Advisor on technical and scientific advertising and public relations to several U.S. Government agencies

and private research and development organizations.

Vice President, M. Belmont Ver Standig, Inc.

Languages: English, Swedish, German.

DR. SIDNEY GLAZER

Linguistic Consultant.

A.B. Hamilton College. Ph. D. (linguistics), Yale University.

Research Analyst, War Department. Chief, Near East Section,

Library of Congress. Chief, Near East Division, Voice of America.

Consultant, Moss Committee on Information, American

Institute of Biological Sciences, Georgetown University.

Visiting lecturer, Middle East Institute.

Author of over 40 books, articles, book reviews.

--22--

COOPERATION WITH C-E-I-R INC.

We are fortunate to have secured the cooperation and assistance of C-E-I-R- Inc. in the proposed venture.

C-E-I-R is equipped with both IBM 704 and 709 computers ( an IBM 7090 will be installed in February of next year) and is the largest independent commercial computer center in the United States. They have offered to supply us with all the machine time and technical assistance required for the project under the same terms and conditions offered government agencies.

C-E-I-R is the only organization in the nation with extensive experience in computer operations as related to machine translation. This experience was acquired when C-E-I-R furnished the equipment and technical assistance on the programming for the CMT system. The demonstrations of this system mentioned earlier were performed on C-E-I-R equipment.

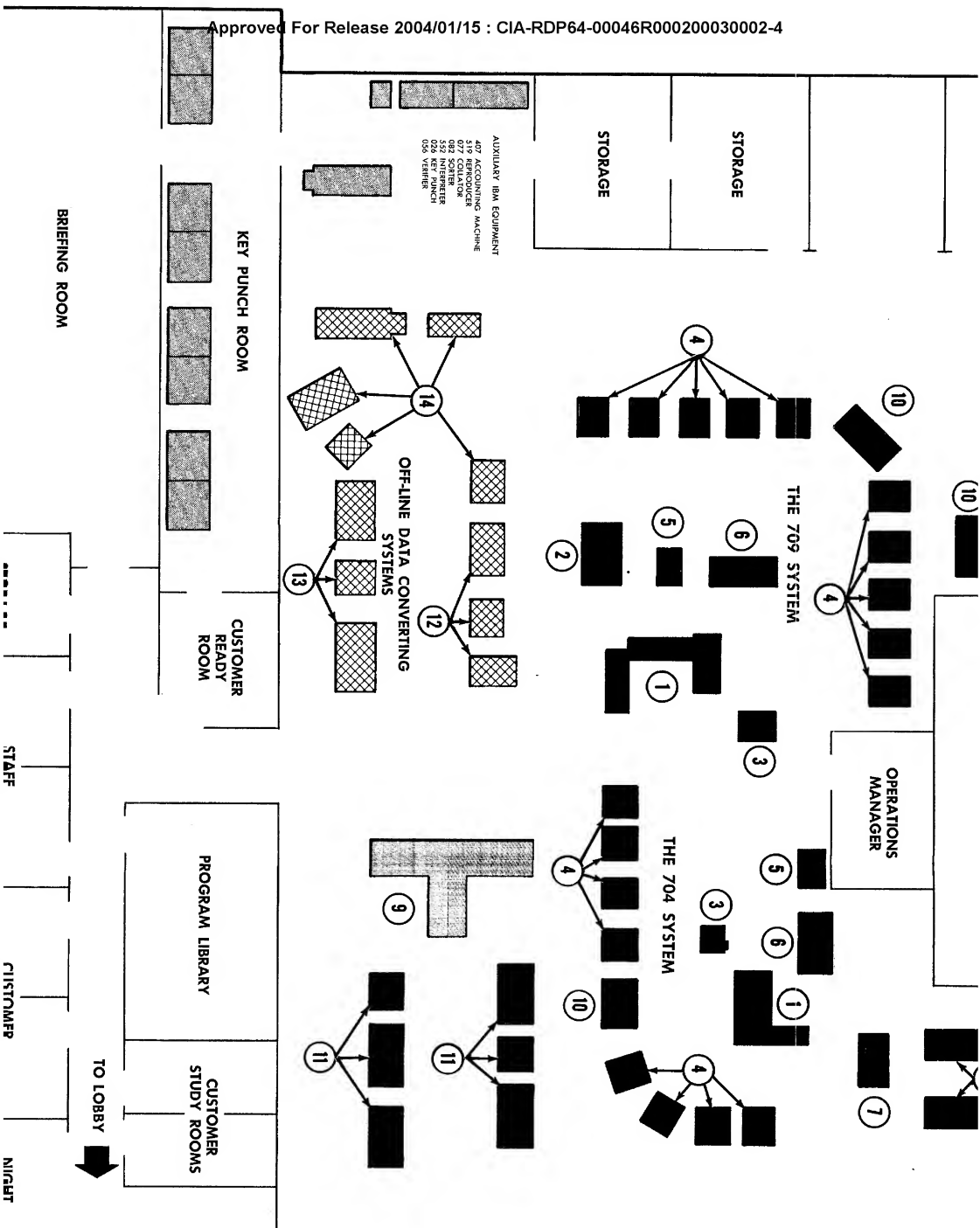
The following information accompanies this proposal:

1. A detailed floor plan of the C-E-I-R Research Center, listing equipment available.
2. A brochure describing the activities of the C-E-I-R Computer Services Division. This brochure includes



resumes of a number of C-E-I-R analysts and programmers.

3. Resumes of additional C-E-I-R staff qualified to work on the proposed project.



- 709, these units can add 40,000 ten-digit numbers per second and can perform logical operations at the same speed.
- 2 Data Synchronizer Unit. Controls all input-output devices for the 709 and makes possible concurrent operation of calculation, input and output; this feature can increase effective speed up to nearly 3 times that of 704. (IBM 766)

#### INPUT UNITS

- 3 Card Reader. Reads instruction and data cards into system at 250 per minute. (IBM 711)
- 4 Magnetic Tape Units. Hold up to 900,000 words, or up to 27,000 IBM card "images". Read into or out of memory units at 2500 words per second. (704 system tapes are IBM 727; 709 tapes are IBM 729-Model 1)

#### OUTPUT UNITS

- 4 Magnetic Tape Units. (See 4 above)
- 5 Card Punch. Punches results directly during calculations at 100 cards per minute. Used primarily for restart or ancillary information. (IBM 721)
- 6 Printer. Prints results directly during calculations at 150 lines per minute. Used primarily for monitoring or operator instructions. (IBM 716)

#### MEMORY UNITS

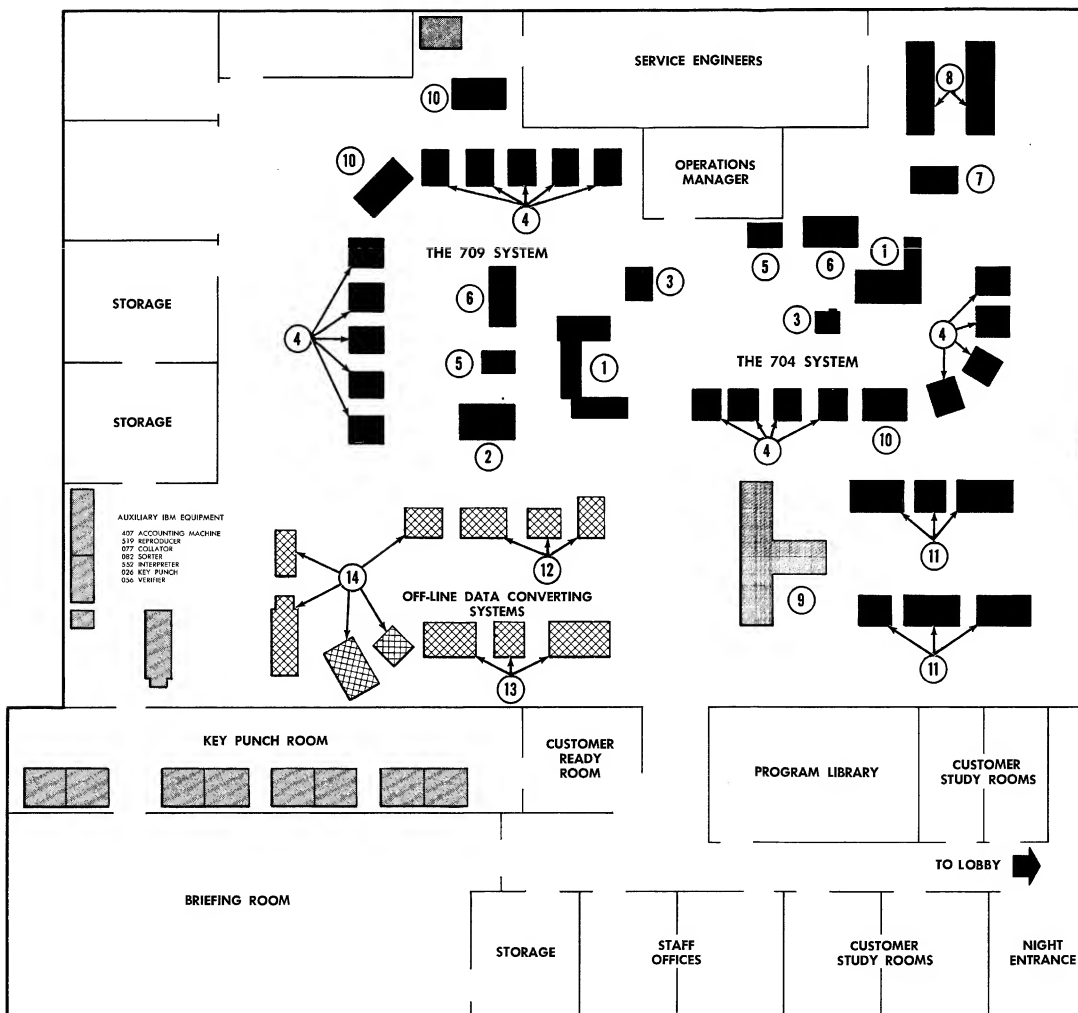
- 7 Magnetic Drum Storage. Provides 8192 words of auxiliary storage, for 704 only. (IBM 733)
- 8 Magnetic Core Storage. Provides 4096 words of "primary" memory each, or a total of 8192 words, for 704 only. (IBM 737)
- 9 Magnetic Core Storage. Provides 32,768 words of storage. Special switching device makes this capacity available to either 709 or 704. (IBM 738)

#### CONTROL UNITS

- 10 Tape Control Unit. Controls up to 10 tape units. (IBM 753)
- 11 Power Regulation and Distribution Units. Provide required AC and DC voltages to 704 and 709 systems. (IBM 736, 741, 746)

#### OFF-LINE DATA CONVERTING EQUIPMENT

- 12 Card-to-Tape Conversion System. Converts data from IBM cards to magnetic tape at 250 cards per minute. (IBM 714, 727, 758)
- 13 Tape-to-Printer System. Transfers data from magnetic



# C-E-I-R's ELECTRONIC DATA PROCESSING FACILITY

- 1 Central Processing Unit. Controls system operations and performs required calculations. On both 704 and 709, these units can add 40,000 ten-digit numbers per second and can perform logical operations at the same speed.
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- 13 Tape-to-Printer System. Transfers data from magnetic tape to printed form at 150 lines per minute.
- 14 Tape-Data Selector System. Selects desired data from magnetic tape and converts to cards at 100 cards per minute or to printed format at 150 lines per minute. (IBM 774, 747, 407, 519)

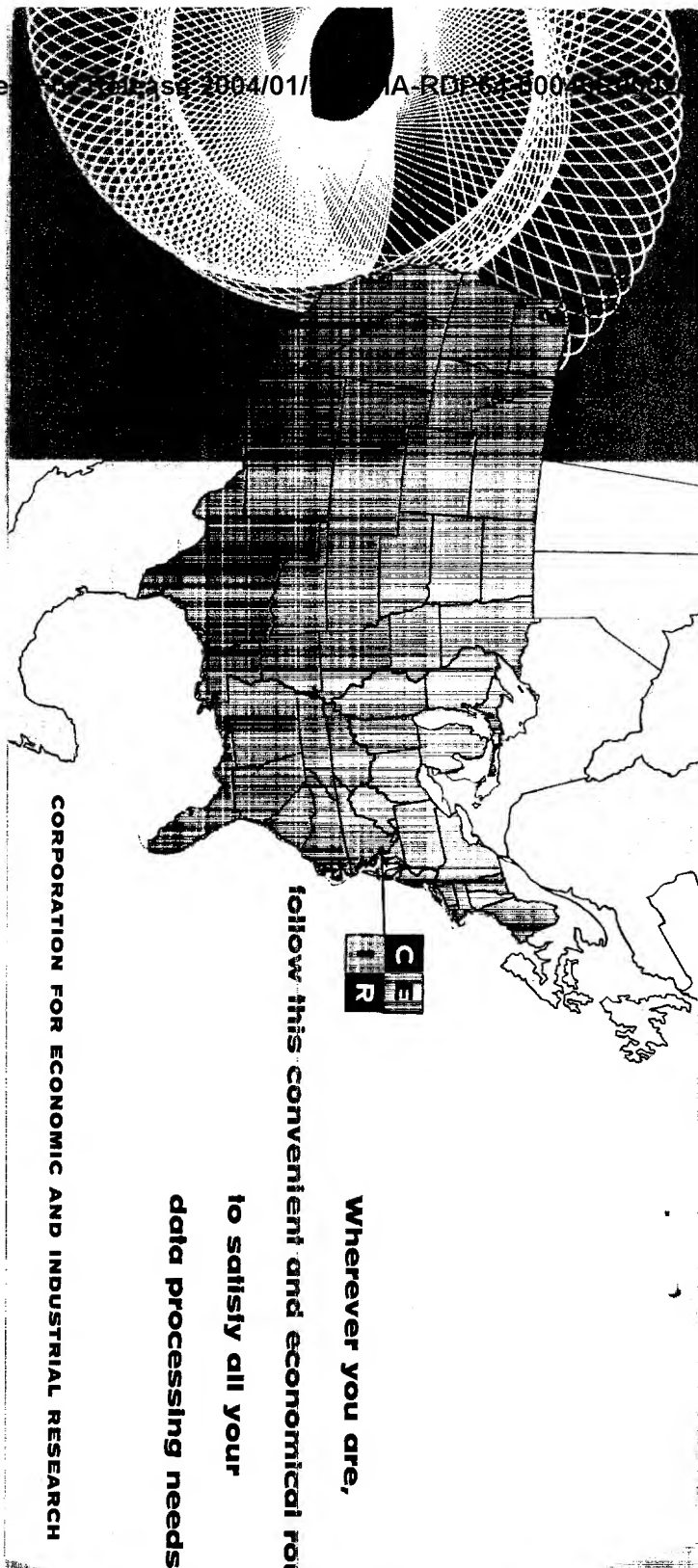
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which is less  
than five minutes  
from our Research Center

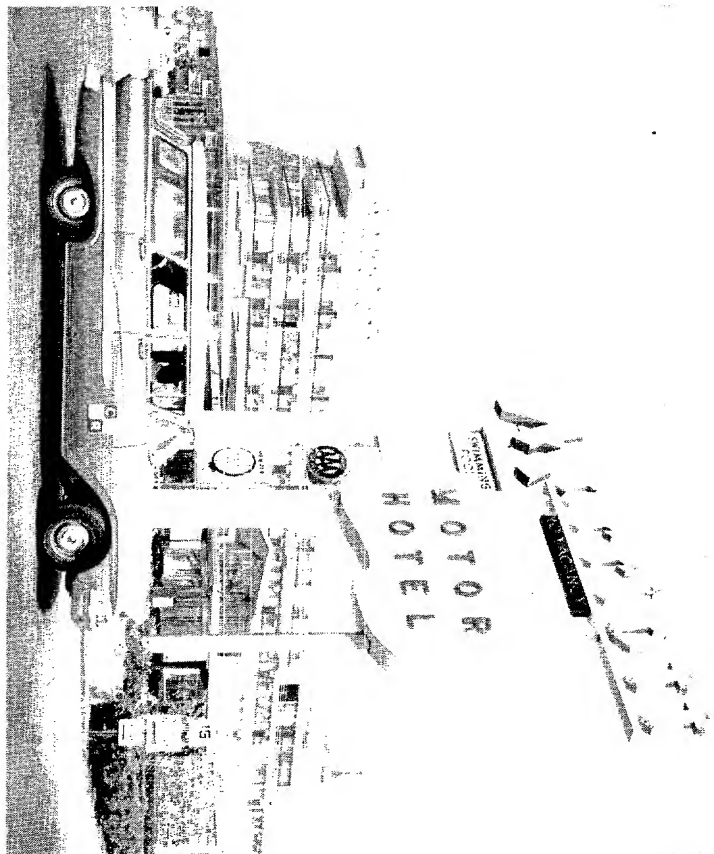
Use **CEIR** for all your 704 and 709 work

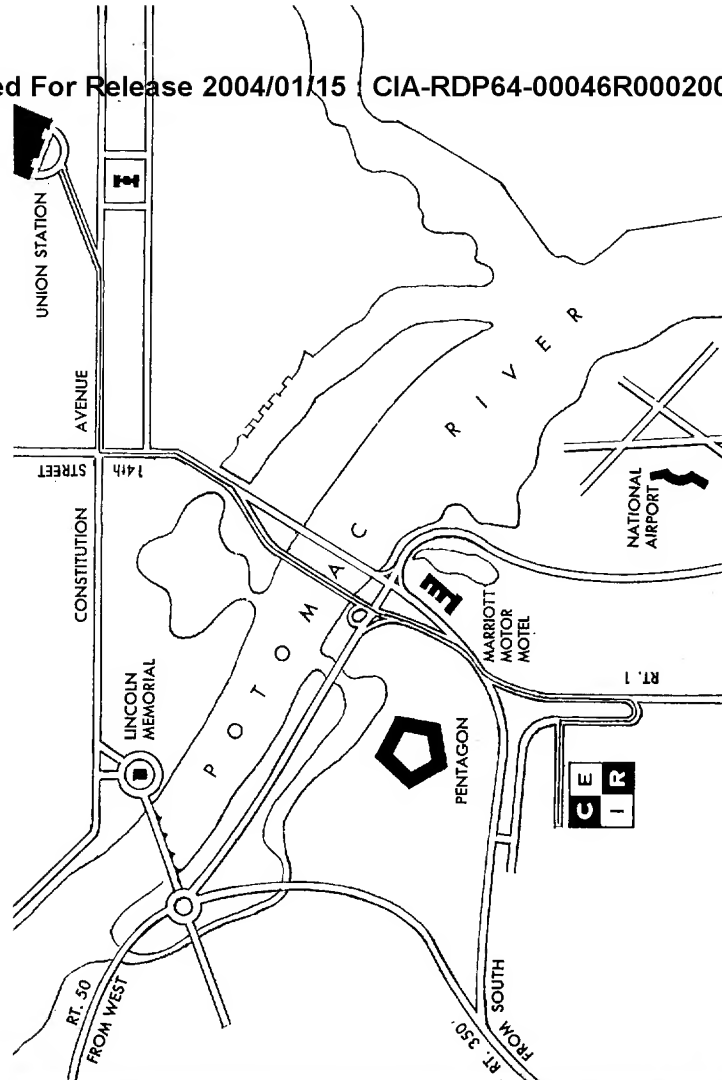


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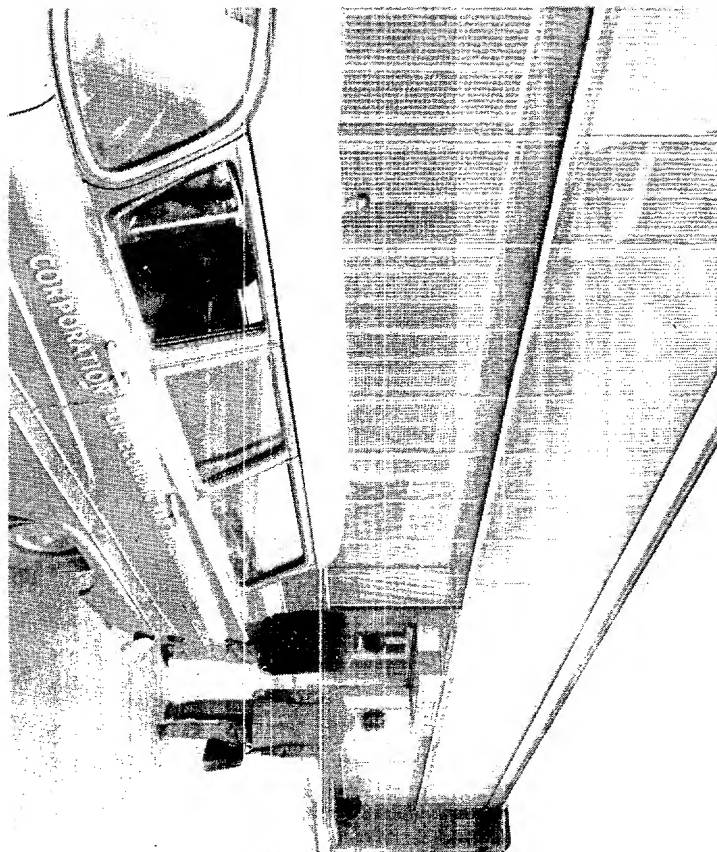


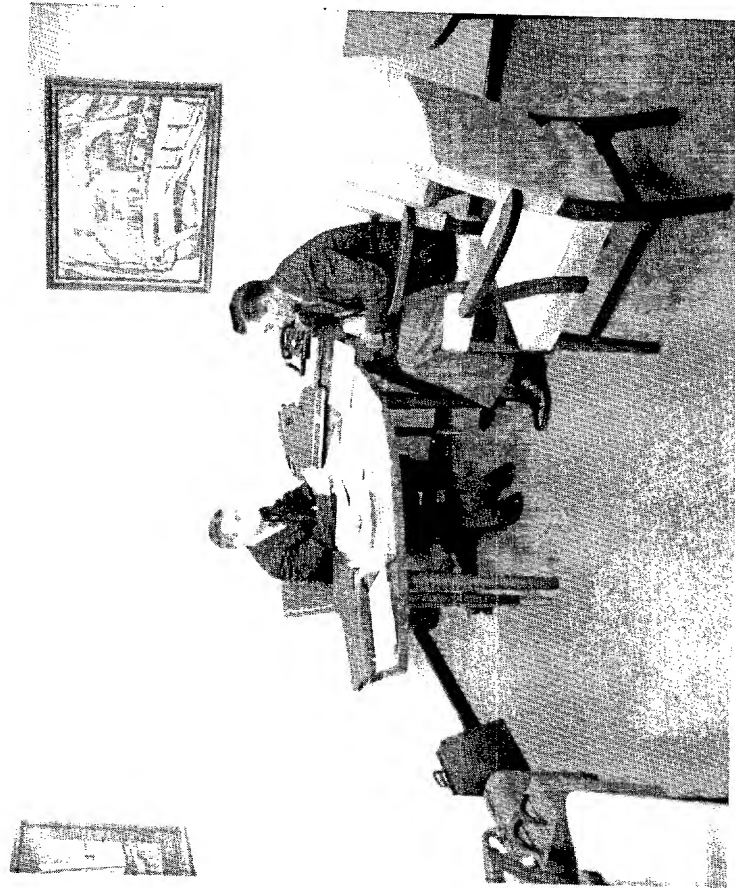


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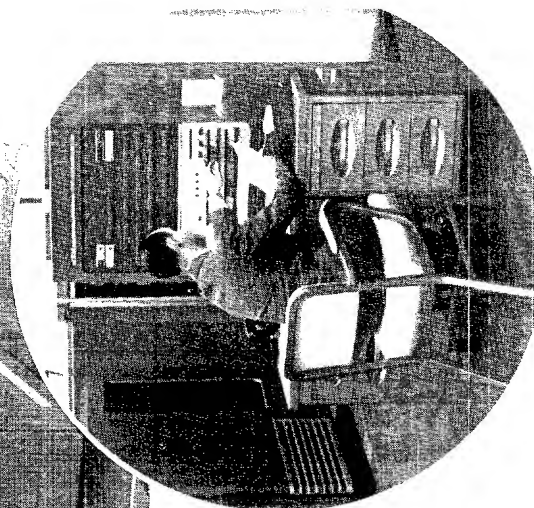
Training of client's personnel in computing and programming techniques (including automatic programming)

Research and development in areas related to electronic data processing

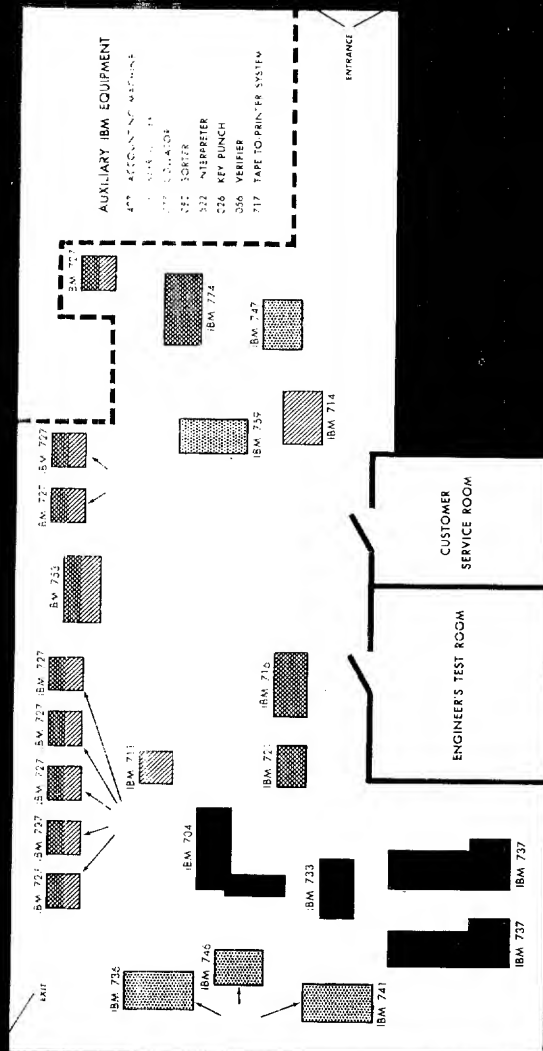
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**HOWARD MORRISON**  
Administrative Officer, CEIR Computer Services Division  
George Washington University, BA in Public Administration;  
Graduate Work, American University; Research Analyst,  
Bureau of the Budget project on inter-industry relationships  
in chemical and allied industries; Bureau of Census and Rice  
Institute, technical advisor on organization and assembly of  
data; U.S. Navy, technical advisor in administration  
of large scale computer laboratory, scheduling, costing and  
estimating.



**CHARLES U. LOUWER**  
Asst. Director for R&D and Training, Computer Services  
Division  
Rutgers University, BS, Electrical Engineering; graduate work  
at Syracuse University; Electrical Engineer, Airborne  
Services Corporation; Electronic Engineer, International Business  
Machines Corporation; Designer, data processing systems,  
National Security Agency; Specialist in electronic and logical  
design of data processing and computing equipment, and of  
input/output equipment and character sensing devices; Co-  
developer of information handling and retrieval system on  
IBM 704.



**ROBERT L. PATRICK**  
Deputy Director Computer Services Division  
University of Nevada, BS, in Mechanical Engineering; for-  
merly Senior Research Engineer, Data Processing Section, Gen-  
eral Motors Research Staff; Aerodynamics Engineer, CONVAIR,  
Fort Worth; Chief Data Reduction Branch, Test Engineering  
Laboratory, USAF Flight Test Center, Edwards AFB, California  
Experience in data processing systems, nuclear and chemical  
engineering simulations, guided missile launch computers, gas  
turbine design calculations, industrial process research,  
Joint design of automatic 704 computer monitoring system,  
and other a series of orders on advanced computer applica-  
tions.



**WILLIAM ORCHARD-HAYS**  
Director, Computer Services Division  
University of California at L.A., MA, Mathematics; Mathema-  
tician and Programming Specialist, Numerical Analysis De-  
partment, RAND Corporation; developed several early inter-  
polative coding setups for IBM CPC; authority on computa-  
tional techniques for Linear Programming and principal  
designer and programmer of the widely used system of 704  
704 Linear Programming codes. Lecturer, instructor, and  
author of several papers on Linear Programming theory and  
computing techniques. Expert in use of EDPM equipment for  
data files and information handling. Course instructor in  
high-speed computer programming.

Approved For Release 2004/01/15 : CIA-RDP64-00046R000200030002-4

## CEIR's 704 Data Processing System

- 1 Central Processing Unit, the system's control center and high-speed computing unit. The 704 operates on fixed-size units of information, commonly called "words," which may be either instructions or numbers (each equivalent to ten decimal digits).
- 2 Alphabetic Printer prints results of computations directly from the 704 at a speed of 150 lines a minute.
- 3 Punched Card Recorder punches results on the standard IBM cards at 100 cards per minute.
- 4 Card Reader introduces instructions and data into system at 250 cards per minute.
- 5 Magnetic Core Storage, primary "memory" units of 4096 words each, any one of which is available to the 704 in 12 millionths of a second. CEIR's two cores have a combined capacity of 8192 words.
- 6 Magnetic Drum Unit provides 8192 words of auxiliary "memory."

- 7 Power Regulation and Distribution Units provide required AC and DC voltages for components of the system
- 8 Tape Control Unit controls tape tape units
- 9 Magnetic Tape Units store and retrieve a medium for holding up to 900,000 words of data or results. Words are moved between the tapes and memory at a speed of 2,500 words per second.
- 10 Data Converters, for transferring data from punched cards to magnetic tape, or from magnetic tape to either cards or report printer, independent of the 704 system. These units yield great economies on 704 time by providing means of fast unloading of 704 output for later processing on conventional equipment, and means of transferring large masses of raw data from cards to tape to obtain the advantage of 704 tape loading.

## CEIR's 709 System

709	Central Processing Unit
738	Magnetic Core Storage Unit— 32,768 words
766	Data Synchronize Unit
755	Tape Control Units (2)
729	Magnetic Tape Units (10)
740	Cathode Ray tube display and film recording unit
780	On-line punched card reader
711	On-line alphabetic printer
716	On-line punched card recorder
721	Power units
736	
741	
746	

\*To be available from January, 1959.

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**NORBERT L. COUDRIET**  
Project Supervisor

B.A. in Mathematics, Lycoming College, 1954; Senior Programmer, Curtiss-Wright, 1954-1958. Special emphasis on compilers, advanced input-output techniques. Experienced in reactor calculations, machine operations and cost and standard cost reports utilizing large scale computers.



**ELI HELLERMAN**  
Project Supervisor

B.S. in Mathematics, George Washington University, 1948. Training Officer, Methods Analysis and Procedures, U. S. Postal Department; Assistant Section Chief, Statistical Operation Group, U. S. Census Bureau; Specialist in large scale matrix manipulation, linear programming and FORTRAN.



**LEWIS PATTON**  
Operations Manager, Computer Services Division  
University of Missouri, BS in Statistics; computer operator, USAF; programmer and operator of high-speed computers, Air Force Test Center; Operations Manager, VITRO Laboratories, Eglin AFB, responsible for operation of multiple-unit computer and data transmission center. Experienced in use of UNIVAC and DATATRON Computers for solving complex mathematical problems. Expert on association of varied input and output devices with large-scale computers for data reduction; Specialist in utilization of computer design logic features for efficient programming.



**ROBERT B. TREADWAY**  
Programming Project Coordinator, Computer Services Division  
Western Maryland College, BA; graduate work at American University; mathematician, Ballistics Research Laboratory, Aberdeen Proving Ground; programmer/analyst, Formulation Branch, Computation Division, Hq. USAF; programmer/analyst, Lockheed Aircraft Corporation. Experienced in the use of computers for Operations Research problems; intelligence file maintenance and retrieval systems; payroll and accounting applications. Familiar with both UNIVAC and IBM equipment.



New York University, BA in Mathematics; Columbia University, MA in Mathematics; Doctorate in Mathematics, Princeton University; Mathematics Department, Queens College, University of the State of New York. Member of Technical Staff, consulting in mathematical statistics and computing, Bell Telephone Laboratories, 1947, specialist in Monte Carlo and simulation techniques, and in applications of modern computers to numerical and statistical problems. Secretary, Association for Computing Machinery. Member of American Statistical Association. Editor, *Journal of the American Mathematical Statistics*.

**HAROLD E. FASSBEG**  
**Deputy Director, Mathematical and Statistical Services Division**  
 Ohio State University, AR in Economics, University of Pittsburgh, MA in Economics, American University; candidate for PhD degree in Economics and Mathematics, Pennsylvania State University; U.S. Graduate Research Fellow, Economic Research Department of State; lecturer on probability theory and linear programming at Department of Agriculture Graduate School; specialist in mathematical model construction and operations research techniques; subscriptions to *Mathematical and Statistical Services Division's* refereed journal.



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 Harvard College, 47 Lawrence Street, Cambridge, Mass. 02138  
 617-495-6200  
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 for correlation and logistics models.

64-00046

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 Degree, Mathematics, 1967, University of Washington; 1968, 1969,  
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## **Partial List of CEIR Clients**

### **Private Industry**

Allis Chalmers Company  
Allegheny Ballistics Laboratory  
American Electric Power Company  
American Gas and Electric Service Corporation  
American Machine and Foundry Company  
Arthur Andersen and Company  
Automation Shares, Inc.  
Babcock and Wilcox Company  
Bell Telephone Laboratories, Inc.  
Brookings Institution  
Capital Airlines  
Chrysler Corporation  
Gellman and Company  
Gelman Construction Company  
General Electric Company  
General Kinetics Corporation  
Georgetown University  
Humble Oil and Refining Company  
Market Research Corporation of America  
Melpar, Incorporated  
Metropolitan Edison Company  
National Planning Association  
The Pillsbury Company  
Radiation, Incorporated  
Radio Corporation of America  
Resources for the Future  
Schlumberger Well Surveying Corporation  
Stanford Research Institute  
Union Carbide Corporation  
University of Maryland  
Vitro Laboratories  
Westinghouse Electric Company

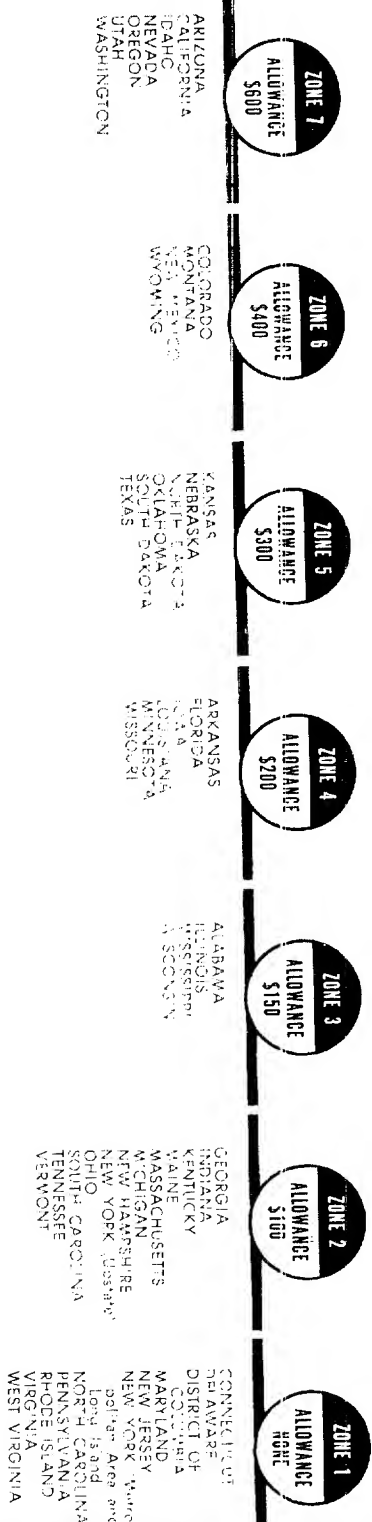
### **Government**

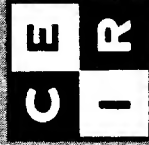
Armed Forces Special Weapons Project  
David Taylor Model Basin  
Department of Health, Education and Welfare  
International Cooperation Administration  
National Capital Planning Commission  
National Science Foundation  
Naval Ordnance Laboratories  
President's Advisory Committee on Weather Control  
Puerto Rico Planning Board  
Puerto Rico Industrial Development Company  
Smithsonian Institution  
U.S. Air Force  
U.S. Army  
U.S. Marine Corps  
U.S. Senate

Note below the allowance you would get

Our new pricing plan provides the allowances indicated below. The full list of services from our Research Center in Arlington, Virginia, are given in the allowance you select. The allowances shown below by States will be made where the client's personnel do computing work at our Research Center. The conditions are as follows: a minimum of five hours of IBM 704 computing time must be used during each visit. For this purpose a visit

is defined as the performance of one or more components regardless of the number of client's personnel required. One or more visits may be made under a contract, or purchase order. One Zone Allowance can be made for each visit. (No Zone Allowances are made in those cases where a quantity discount has been allowed under a specially negotiated contract.)





CEIR'S staff will be happy to discuss your problems with you. Below are a few of the areas in which we have acquired a reputation for outstanding accomplishment:

- Linear Programming
- Matrix Calculations
- Information Storage and Retrieval
- Extremely Advanced "Logical" Systems
- Simulation of Weapons Systems
- Scheduling of Transportation Equipment
- Nuclear Design Calculations
- Simulation of Mechanical and/or Electronic Systems incidental to design studies
- Multiple Regression and Correlation (and other Statistical Analyses)
- Mechanical Language Translation

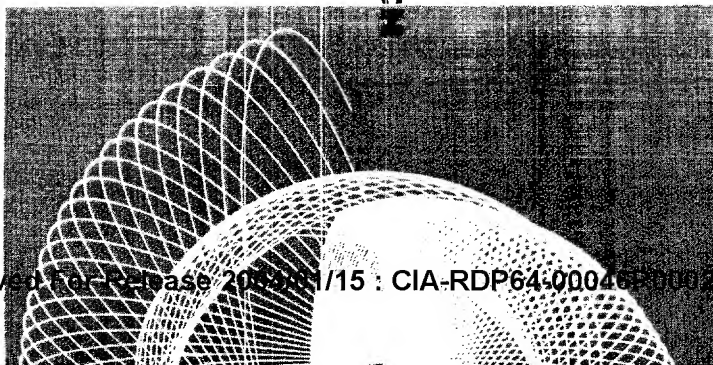
**CORPORATION FOR ECONOMIC AND INDUSTRIAL RESEARCH**

**RESEARCH CENTER**

1200 Jefferson Davis Highway, Arlington 2, Virginia: Phone OTis 4-6377

**WASHINGTON OFFICE**

734 Fifteenth Street, N. W., Washington 5, D. C. Phone National 8-1554







## CEIR's Program Library

CEIR's Computer Services Division makes every attempt to keep a complete and up-to-the-minute program library for the use of its 704 customers. Over 150 active routines are on hand, plus many others in less frequent use. The majority of these are SHARE routines, though several have been developed at CEIR. They have been segregated into three categories on the basis of usefulness and efficiency. The SHARE classification code is used as an integral part of CEIR's internal numbering system, and programs are also cross-filed by originating installation. A full-time Computer Services Division Librarian is on hand to assist in locating programs and write-ups. Other SHARE routines are available on two or three days notice in most instances.

The assembly systems available are:

- UA-SAP1, 2 in separate card versions for standard binary with and without symbol table, and 24 word card binary without symbol table.
- NY SP1, 2, modified SAP1, 2 on CEIR master tape 1.
- NY CAP3, modified UA-SAP3-7 on standard CEIR master tape 2.
- GM I O System on tape.
- NY API on tape on CEIR master tape 1.

**A wide variety of 709 programs, responsive to customer needs, will be added to CEIR's program library as they are developed by CEIR, IBM and other 709 centers**

Among the debugging routines available are:

- NY DS1 — Memory Dump (including tapes and drums) on both binary cards and both CEIR master tapes.
- NY SNAP — Snap-traces in both CEIR master tapes.
- MI PMR1 — MIT Post-mortem routines on CEIR master tape 2.

A variety of sub-routines for the elementary and more common non-elementary functions are of course available, as well as integration and differential equation-solving routines. FORTRAN is used extensively at CEIR and expert advice on this automatic coding system can be obtained within the Computer Services Division.

Internally, CEIR has always specialized in large-scale matrix work. Abstract matrix routines for matrix algebra, manipulation, and solution of simultaneous equations are available for both single and double precision work as well as complex arithmetic.

Linear Programming computation is a particular specialty at CEIR, and we feel our experience in this area is unequalled.

Besides immediately available canned routines, the Computer Services Division programming staff has extensive experience in and numerous program "sorts" for data processing, information handling, and report generation systems. If you have a problem in this area, the chances are excellent that we can provide an efficient tailor-made system in minimum time at reasonable cost.

LEWIS REINWALD  
Head, Statistical Programs Section  
Computer Services Division

Academic Background

Ohio University, B.A., Major, Geography; Minors, Geology, Math.

Clark University, M.A., Major: Urban Geography, Minor: Economic Geography; Ph.D. in Geography completed except for dissertation

American and George Washington Universities, 40 hours mathematics and statistics

Professional Background

Statistical Assistant, Methods Analysis Dept., Crowell Collier Publishing Company

Intelligence Analyst, Urban Area Analysis, USAF

Research Analyst, development quantitative methods for social science research, Library of Congress

Fields of Special Competence

Statistical and matrix routines;

New applications of computers in statistical, social and geographical analyses; and

Design of matrix operation codes

C E  
R

BERYL D. BLICKSTEIN

Programmer, Computer Services Division

Academic Background

B. S. in Physics, Case Institute of Technology  
M. S. in Physics, Candidate, University of Maryland

Professional Background

Engineer, Special Purpose Computer Division, Melpar, Inc.,  
Falls Church, Virginia

Senior Programmer, C E I R, INC.

Presently Section Head, Program Systems Section,  
C-E-I-R, INC.

Fields of Special Competence

Co-Author C-E-I-R 709 System (SCRAM)

Chief Programmer on Joint C-E-I-R, INC.-Georgetown  
University Machine Translation Project for IBM 704

Project Leader on Complex Trajectory Calculations  
for IBM 704

Logical Design of Stored Program Computers

C E  
I R

JOSEPH A. DELARIO

EDPM Program Analyst

Academic Background

Fairleigh-Dickinson College, BA, Economics

Professional Background

Computer programmer, Curtiss-Wright Aircraft Company

Designer of large automatic computer systems

Contributor to automatic data processing system techniques

Fields of Special Competence

Expert in solving logical problems applicable to large  
scale electronic data processing machines

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